

WHAT IS CLAIMED:

1. A design template comprising:
a torso section being one of a group comprising a 95th percentile male, 50th percentile male and 5th percentile female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture.

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2. A design template as set forth in claim 1 wherein said torso section has a portion of an outer contour conforming to a deformed shape of an interface contour between a seat and a seated occupant.

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3. A design template as set forth in claim 2 wherein said torso section includes anatomical details located relative to each other and the interface contour is located relative to said anatomical details.

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4. A design template as set forth in claim 1 wherein said torso section is made of a sheet of a rigid material or represented in electronic media.

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5. A design template as set forth in claim
1 wherein said torso section includes indicia of
skeletal landmarks for a shoulder joint and a hip joint
and an axis connected therebetween.

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6. A design template as set forth in claim
1 wherein said torso section includes a centerline
projection of a pelvis with indicia representing an
ischial tuberosity, anterior superior iliac spine, pubic
10 symphysis and sacrum.

7. A design template as set forth in claim
1 wherein said torso section includes indicia of spinal
landmarks marked along a back portion thereof.

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8. A design template as set forth in claim
1 wherein said torso section includes an angular scale
for torso angle.

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9. A design template as set forth in claim
1 wherein said torso section includes an angular scale
for hip angle.

10. A design template as set forth in claim
1 wherein said torso section has an anterior shape that
is anthropometrically and anatomically correct.

5 11. A design template as set forth in claim
1 wherein said torso section includes indicia for a
shoulder joint, neck/shoulder junction and a sternum.

10 12. A design template as set forth in claim
1 including a thigh section connected to said torso
section.

15 13. A design template as set forth in claim
12 wherein said thigh section is one of a group
comprising a 95th percentile male, 50th percentile male
and 5th percentile female.

20 14. A design template as set forth in claim
12 wherein said thigh section is made of a sheet of
rigid material or represented in electronic media.

15. A design template as set forth in claim
12 including a hinge at a hip joint to connect said
thigh section to said torso section.

5 16. A design template as set forth in claim
12 wherein said thigh section includes indicia of a hip
joint and knee joint and an axis therebetween.

10 17. A design template as set forth in claim
12 wherein said torso section and said thigh section are
geometrically congruent in a seated posture where they
overlap on a seat cushion.

15 18. A design template as set forth in claim
12 wherein said thigh section has a deformed bottom
contour representing a change from hard bone tissue to
soft muscle tissue in contact with a seat cushion.

20 19. A design template as set forth in claim
12 wherein said thigh section includes indicia of a
pointer for hip angle and an angular scale for knee
angle.

20. A design template as set forth in claim
12 including a calf section connected to said thigh
section.

5 21. A design template as set forth in claim
20 wherein said calf section is one of a group
comprising a 95th percentile male, 50th percentile male
and 5th percentile female.

10 22. A design template as set forth in claim
20 wherein said calf section is made of a sheet of rigid
material or represented in electronic media.

15 23. A design template as set forth in claim
20 including a hinge at a knee joint to connect said
calf section to said thigh section.

20 24. A design template as set forth in claim
20 wherein said calf section includes indicia of a knee
joint and ankle joint and an axis therebetween.

25. A design template as set forth in claim
20 wherein said calf section includes indicia of a
pointer for knee angle and a scale for ankle angle.

5 26. A design template as set forth in claim
20 wherein said calf section and said thigh section are
geometrically congruent in a seated posture where they
overlap on anterior and superior surfaces.

10 27. A design template as set forth in claim
20 including a shoe section connected to said calf
section.

15 28. A design template as set forth in claim
27 wherein said shoe section is one of a group
comprising a 95th percentile male, 50th percentile male
and 5th percentile female.

20 29. A design template as set forth in claim
27 wherein said shoe section is made of a sheet of rigid
material or represented in electronic media.

30. A design template as set forth in claim
27 including a hinge at an ankle joint to connect said
shoe section to said calf section.

5 31. A design template as set forth in claim
27 wherein said shoe section includes indicia for an
ankle joint and a pointer for an ankle angle.

10 32. A design template as set forth in claim
27 wherein said shoe section has an axis from a ball of
foot to heel of foot inside a shoe.

15 33. An occupant restraint system for a seat
comprising:

a lap belt being anchored to vehicle structure
to extend below an anterior superior iliac spine and
above an anterior inferior iliac spine for a design
template with a torso section having an ERECT posture;
and

20 a shoulder belt being anchored to vehicle
structure to extend between a first predetermined
distance from a centerline of the seat to a shoulder

joint for a design template with a torso section being one of a group comprising a 5th percentile female, a 95th percentile male and a 50th percentile male and a second predetermined distance from the centerline of the seat
5 to a neck/shoulder junction for the design template with the torso section being one of the group of the 5th percentile female, 50th percentile male or the 95th percentile male.

10 34. An occupant restraint system as set forth in claim 33 wherein said first predetermined distance is 190 mm for the 5th percentile female, 246 mm for the 50th percentile male and 267 mm for the 95th percentile male, and said second predetermined distance is 51 mm for the
15 5th percentile female, 65 mm for the 50th percentile male and 71 mm for the 95th percentile male.

20 35. A method of establishing occupant accommodation criteria in a vehicle package based on a predetermined class of vehicles comprising:

 providing a design template having a torso section being one of a group comprising a 95th percentile

male, 50th percentile male and 5th percentile female having each being one of a group comprising an ERECT posture, a NEUTRAL posture and a SLUMPED posture and having a leg section;

5 defining an accelerator to provide a heel point of the leg section;

defining deflection of a seat whether it is high deflection (soft), medium deflection (medium) or low deflection (hard);

10 positioning the design template in the vehicle such that the heel of the leg section is at the heel point and angles of the leg section are within predetermined comfort ranges;

15 establishing a seat height from a floor to a bottom of the torso section at I_D^o; and

establishing an H-point reference point (HptRP) relative to the heel point in a vehicle axis system by the design template.

20 36. A method as set forth in claim 35 including the step of adjusting joint angles at an

ankle, knee and hip of the design template to lie within a predetermined range.

37. A method as set forth in claim 35
5 including the step of reclining the torso section a predetermined angle from vertical.

38. A method as set forth in claim 35
including locating an eye relative to a shoulder joint.

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39. A method as set forth in claim 35
including the step of marking a location of a heel point and H-point.

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40. A method as set forth in claim 35
including the step of positioning a heel on a depressed floorboard with a foot axis parallel to an undepressed accelerator pedal axis.

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41. A method as set forth in claim 35
including the step of locating a center of the hip joint to define the H-point.

42. A method as set forth in claim 35
including the step of positioning a heel of the 5th
percentile female having one of the ERECT posture,
NEUTRAL posture or SLUMPED posture in the vehicle
5 package.

43. A method as set forth in claim 35
including the step of positioning a heel of the 50th
percentile male having one of the ERECT posture, NEUTRAL
10 posture or SLUMPED posture in the vehicle package.

44. A method as set forth in claim 35
including the step of constructing a line parallel to a
travel axis of a seat track in the vehicle package.
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45. A method as set forth in claim 35
including the step of defining the H-point reference
point at the rearmost and downmost position of the seat
in the vehicle package.
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46. A method for designing a seat comprising:
selecting at least one design template having
a torso section being one of a group comprising a 95th
percentile male, 50th percentile male and 5th percentile
5 female having each being one of a group comprising an
ERECT posture, a NEUTRAL posture and a SLUMPED posture
and having a leg section; and
forming load supporting contours of the seat
for the at least one design template; and
10 forming unloaded contours of the seat for the
at least one design template.

47. A method as set forth in claim 46
including the step of tracing an interface contour of
15 the design template.

48. A method as set forth in claim 46
including the step of estimating a first point of the
load supporting contours of a seat back at S° under
20 occupant load.

49. A method as set forth in claim 48 including the step of estimating a second point at S^U on the unloaded contour of the seat back.

5 50. A method as set forth in claim 46 including the step of estimating a first point of the load supporting contours of a seat back at L° under occupant load.

10 51. A method as set forth in claim 50 including the step of estimating a second point at L^U on the unloaded contour of the seat back.

15 52. A method as set forth in claim 46 including the step of estimating a first point of the load supporting contours of a seat cushion at I_D° under occupant load.

20 53. A method as set forth in claim 52 including the step of estimating a second point at I_D^U on the unloaded contour of the seat cushion.

54. A method as set forth in claim 46 including the step of estimating a first point of the load supporting contours of a seat cushion at T^o under occupant load.

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55. A method as set forth in claim 54 including the step of estimating a second point at T^u on the unloaded contour of the seat cushion.

10 56. A method as set forth in claims 49, 51, 53, 55 including the step of plotting locations of S^u , L^u , I_b^u , and T^u points to form the unloaded contour of the seat for the design template.

15 57. A method as set forth in claim 56 including the step of optimally matching the unoccupied load support points for the other torso sections and postures of the design template to define the unoccupied contour.

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58. A method as set forth in claim 57
including the step of constructing an unloaded point S^U
for each of the design templates.

5 59. A method as set forth in claim 57
including the step of constructing an unloaded point L^U
for each of the design templates.

10 60. A method as set forth in claim 57.
including the step of constructing an unloaded point I_D^U
for each of the design templates.

15 61. A method as set forth in claim 57
including the step of constructing an unloaded point T^U
for each of the design templates.

62. A method as set forth in claim 46
including the step of defining the unoccupied load
support zone for the thorax.

63. A method as set forth in claim 46 including the step of defining the unoccupied seat contour for the lumbar.

5 64. A method as set forth in claim 46 including the step of defining the unoccupied seat contour for the ischium.

10 65. A method as set forth in claim 46 including the step of defining an area for a seat suspension in the seat.

15 66. A method as set forth in claim 46 including the step of defining an unoccupied seat contour for the thigh.

67. A method as set forth in claim 46 including the step of defining a waterfall region of an unoccupied seat.

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68. A method of using a design template to design a vehicle seat comprising:

providing at least one design template having
a torso section being one of a group comprising a 95th
percentile male, 50th percentile male and 5th percentile
female having each being one of a group comprising an
5 ERECT posture, a NEUTRAL posture and a SLUMPED posture;

establishing occupant accommodation criteria
based on positioning the at least one design template in
a predetermined class of vehicles to define seat height
and seat track displacement to accommodate each design
10 template on a seat having a seat cushion and a seat back
in a vehicle representing the vehicle package criteria;

and

defining at least one from a group comprising
unloaded contours on the seat at S^U, L^U, I_D^U and T^U;
15 defining at least one from a group comprising
a seat back height, seat cushion length, head restraint
position, thorax support, lumbar support, seat back bite
line region, seat cushion bite line region, seat
cushion bolster and seat suspension for the seat
20 relative to the design template.

69. A method as set forth in claim 68 wherein
said step of defining a seat back height for the seat
relative to the design template comprises terminating a
seat back height relative to the design template at T2
5 on the torso section of the 50th percentile male having
the ERECT posture.

70. A method as set forth in claim 68 wherein
said step of defining a seat back height for the seat
10 relative to the design template comprises locating a top
cross member of the seat back frame relative to the
design template at a position equal to or higher than T4
on the torso section of the 50th percentile male having
the ERECT posture.

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71. A method as set forth in claim 68 wherein
said step of defining a head restraint position for the
seat relative to the design template comprises
calculating a position of an eye relative to the design
20 template, locating a back of a head for the torso
section of the 95th percentile male having the ERECT
posture relative to the calculated position of the eye,

and defining a lowest maximum height of the head restraint relative to the design template at the back of the head for the torso section of the 95th percentile male having the ERECT posture.

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72. A method as set forth in claim 68 wherein said step of defining a thorax support for the seat relative to the design template comprises defining an area for the thorax support relative to the design template between a thorax load zone for the torso section of the 95th percentile male having the ERECT posture and the thorax load zone for the torso section of the 5th percentile female having the SLUMPED posture.

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73. A method as set forth in claim 68 wherein said step of defining a lumbar support for the seat relative to the design template comprises locating a two-way, horizontal displacement, adjustable lumbar support for the seat relative to the design template between L3 and L4 for the torso section of the 95th percentile male having the ERECT posture.

74. A method as set forth in claim 68 wherein
said step of defining a lumbar support for the seat
relative to the design template comprises locating
vertical displacement of an adjustable lumbar support
5 for the seat relative to the design template between L2
and L5 for the torso section of the 95th percentile male
having the ERECT posture.

75. A method as set forth in claim 68 wherein
10 said step of defining a lumbar support for the seat
relative to the design template comprises defining
structural mechanics of a deformable pad of the seat
back relative to the design template so that the pad
bends easily at T12 for the torso section of the 95th
15 percentile male having the ERECT posture and at S1 for
the torso section of the 95th percentile male having the
ERECT posture.

76. A method as set forth in claim 68 wherein
20 said step of defining a seat back bite line region for
the seat relative to the design template comprises
locating structure in the seat back to restrain rearward

motion of the occupant into the seat back relative to the design template within a region bounded by S1 for the torso section of the 95th percentile male having the ERECT posture and S1 for the torso section of the 5th percentile female having the NEUTRAL posture.

77. A method as set forth in claim 68 wherein said step of defining a seat back bite line region for the seat relative to the design template comprises 10 locating non-deformable structures in the seat back relative to the design template equal to or above S1 for the torso section of the 5th percentile female having the NEUTRAL posture.

15 78. A method as set forth in claim 68 wherein said step of defining a seat cushion bite line region for the seat relative to the design template comprises locating non-deformable structures relative to the design template below a horizontal tangent at an I_D^o load 20 supporting contour for the torso section of the 95th percentile male having the ERECT posture.

79. A method as set forth in claim 68 wherein
said step of defining a seat suspension for the seat
relative to the design template comprises defining an
area for the seat suspension relative to the design
template between a furthest forward and rearward ischial
load points for the torso section of the 95th percentile
male having the SLUMPED posture and for the torso
section of the 5th percentile female having the ERECT
posture.

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80. A method as set forth in claim 68 wherein
said step of defining a seat cushion length for the seat
relative to the design template comprises terminating a
length of the seat cushion relative to the design
template from I_D on the torso section of the 5th
percentile female having the ERECT posture to a vertical
line passing through a knee point and a thigh axis on
the torso section of the 5th percentile female having the
NEUTRAL posture.

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81. A seat comprising:

a seat cushion;

a seat back associated with said seat cushion;

and

5 at least one from a group comprising a seat
back height, seat cushion length, head restraint
position, thorax support, lumbar support, seat back bite
line region, seat cushion bite line region and seat
suspension being defined for said seat cushion and said
10 seat back relative to a design template having a torso
section being one of a group comprising a 95th percentile
male, 50th percentile male and 5th percentile female
having each being one of a group comprising an ERECT
posture, a NEUTRAL posture and a SLUMPED posture and
15 having a leg section.

82. A seat as set forth in claim 81 wherein
said seat back height of said seat back terminates at T2
on the torso section of the 50th percentile male having
20 the ERECT posture for the design template.

83. A seat as set forth in claim 81 wherein
said seat back includes a top cross member at a position
equal to or higher than T4 on the torso section of the
50th percentile male having the ERECT posture for the
5 design template.

84. A seat as set forth in claim 81 wherein
said head restraint position is located relative to a
position of a back of a head for the torso section of
10 the 95th percentile male having the ERECT posture for the
design template.

85. A seat as set forth in claim 81 wherein
said seat cushion bite line region includes non-
15 deformable structures located below a horizontal tangent
at an I_D load supporting contour and non-deformable
structures located rearward of a tangent to the S° and L°
points for the torso section of the 95th percentile male
having the ERECT posture for the design template.

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86. A seat as set forth in claim 81 wherein
said seat back bite line region includes structure in

said seat back to restrain rearward motion of an occupant into said seat back located within a region bounded by S1 for the torso section of the 95th percentile male having the ERECT posture and S1 for the 5th percentile female having the NEUTRAL posture for the design template.

87. A seat as set forth in claim 81 wherein said seat back bite line region includes non-deformable structures in said seat back located equal to or above S1 for the torso section of the 5th percentile female having the NEUTRAL posture for the design template.

88. A seat as set forth in claim 81 wherein said two-way, horizontal displacement, lumbar support is located between L3 and L4 for the torso section of the 95th percentile male having the ERECT posture for the design template.

20 89. A seat as set forth in claim 81 wherein said lumbar support is located for vertical displacement between L2 and L5 on the torso section of the 95th

percentile male having the ERECT posture for the design template.

90. A seat as set forth in claim 81 wherein
5 said lumbar support includes a deformable pad that bends easily at T12 and S1 for the torso section of the 95th percentile male having the ERECT posture for the design template.

10 91. A seat as set forth in claim 81 wherein
said seat cushion length terminates from I_D on the torso section of the 5th percentile female having the ERECT posture to a vertical line passing through a knee point with a thigh axis parallel to an axis passing through I_D
15 and T load supporting contours on the torso section of the 5th percentile female having the NEUTRAL posture for the design template.

20 92. A seat as set forth in claim 81 wherein
said seat suspension is defined in an area between a furthest forward and rearward ischial load zone for the

torso section of the I_D load supporting contour for the design template.

93. A seat as set forth in claim 81 including
5 a seat anti-submarining restraint system defined in an area between a furthest forward ischial load zone for the torso section of the I_D load supporting contour for the design template and the vertical barrier at the nose of the seat cushion to horizontal motion of the ischium
10 for the design template.

94. A seat as set forth in claim 81 wherein said thorax support is defined in an area between a thorax load zone for the torso section of the 95th percentile male having the ERECT posture and a thorax load zone for the torso section of the 5th percentile female having the SLUMPED posture for the design template.
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20 95. A seat as set forth in claim 81 including a structural cross-member of the seat back anchored to the seat back frame at the level of the S1 for the

design template with the torso section being one of the 5th percentile female having an ERECT posture and the 95th percentile male having a NEUTRAL posture.

5 96. A seat as set forth in claim 81 including
an anti-submarining region in the most forward portion
of the seat cushion having a vertical barrier to
horizontal motion of the ischium in a design template
being the 5th percentile female having one of the group
10 of ERECT, NEUTRAL or SLUMPED postures.